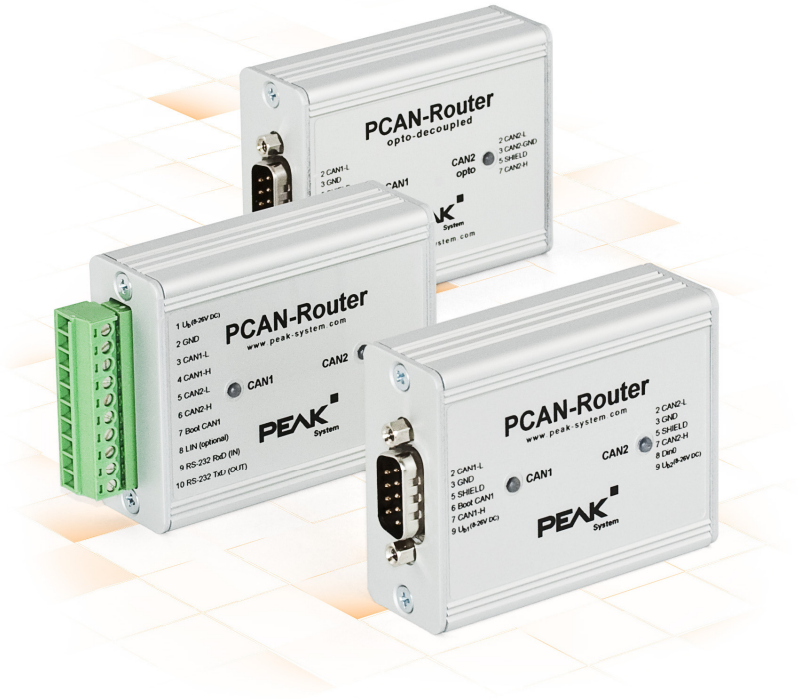
PCAN-Router

Universal Programmable CAN Converter

User Manual



Document version 1.4.0 (2013-10-31)

PEAK System

Products taken into account

Product Name	Model	Part number
PCAN-Router	2 D-Sub connectors, additional digital input	IPEH-002210
PCAN-Router	Screw terminal block, additional serial interface	IPEH-002210-P
PCAN-Router opto-decoupled	2 D-Sub connectors, galvanic isolation for connector CAN2, additional digital input	IPEH-002211

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Document version 1.4.0 (2013-10-31)

Contents

1 Introduction 5
1.1 Properties at a Glance 5
1.2 Scope of Supply 6
1.3 Prerequisites for Operation 6

2 Connectors and Coding Solder Jumpers 7
2.1 D-Sub Connectors 8
2.1.1 Supplying External Devices via the CAN Connector (D-Sub only) 10
2.2 Screw Terminal Block 11
2.3 J4 Connector Panel: Serial Ports 12
2.4 J5 Connector Panel: JTAG Ports 13
2.5 Coding Solder Jumpers 14

3 Operation 16

4 Software 17
4.1 Installing the GNU ARM Toolchain 17
4.2 Library 18
4.3 Firmware Examples 18
4.3.1 Compiling a Firmware Example 19

5 Firmware Upload 20
5.1 Uploading Firmware via CAN 20
5.1.1 System Requirements 20
5.1.2 Preparing Hardware and Software 21
5.1.3 Uploading the Firmware 22
5.2 Uploading Firmware via the Serial Connections 25

6 Technical Specifications 27

Appendix A CE Certificate 29

Appendix B Dimension Drawings 30

Appendix C Port Assignment of the Microcontroller 31

1 Introduction

The PCAN-Router is a module with two CAN channels, the data traffic of which is processed by a freely programmable microcontroller. This means that incoming CAN messages can be individually evaluated, converted, and filtered in order to then send the adjusted CAN messages to the respective other network.

You can copy any firmware you have developed yourself to the PCAN-Router via the bootloader, which has already been implemented, by using CAN. The PCAN-Router is supplied with an example firmware which forwards CAN messages 1:1 between the two channels at 500 kbit/s. The respective source code is included on the supplied DVD.

1.1 Properties at a Glance

- Microcontroller of the NXP LPC21 series (16/32-bit ARM CPU)
- External 32-kByte EEPROM
- Two High-speed CAN channels (ISO 11898-2) with 40 kbit/s to 1 Mbit/s (lower bit rates on request)
- One additional LIN channel on request
- Galvanic isolation of the D-Sub connector CAN 2 for the opto-decoupled model
- Status indication with two duo LEDs
- Two 9-pin D-Sub connectors or one 10-pin screw terminal block (Phoenix)
- Aluminum profile casing, DIN rail mounting option on request
- Supply voltage from 8 to 30 V

- Extended operating temperature range of -40 to +85 °C (-40 to +185 °F)
- Import of a new firmware via CAN
- Additional digital input (only applies to models with D-Sub connectors IPEH-002210/11)
- Additional serial RS-232 interface (only applies to model with screw terminal block IPEH-002210-P)
- 4-bit coding of the hardware by solder jumpers

1.2 Scope of Supply

- PCAN-Router in aluminum profile casing
- 10-pin screw terminal block (IPEH-002210-P only)
- Windows development software (Yagarto GNU ARM toolchain, flash program)
- DVD with library, programming examples, and manual in PDF format

1.3 Prerequisites for Operation

- Voltage supply within a range of 8 to 26 V DC (up to 30 V with IPEH-002210(-P) from ser. no. 01000 and IPEH-002211 from ser. no. 00020)
- For uploading a new firmware via CAN:
  - CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
  - Operating system Windows 8/7/Vista/XP (32/64-bit)

2 Connectors and Coding Solder Jumpers

Depending on the model the PCAN-Router has the following connectors:

- two 9-pin D-Sub connectors (IPEH-002210/11)
- one 10-pin screw terminal block (IPEH-002210-P)

For direct access to the serial and debugging ports of the micro-controller, additional – yet not equipped – connector panels are available on the board of the PCAN-Router.

Furthermore the PCB has four coding solder jumpers in order to assign a fixed status to the corresponding input bits of the micro-controller. A concrete application is to identify a PCAN-Router on the CAN bus for a firmware upload, especially if there are several routers connected and in operation.

The following subsections describe each connector assignment.

2.1 D-Sub Connectors

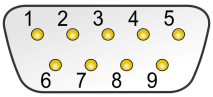
(IPEH-002210 and IPEH-002211)

The two D-Sub connectors are used for the CAN channels CAN1 and CAN2.

The voltage supply can be done via both connectors, with the opto-decoupled model only via connector CAN1. The supply connections $+U_{b1}$ and $+U_{b2}$ are connected internally in a reactionless configuration. This means that different power sources can be connected if applicable.

Connector CAN1 additionally offers an input to activate the bootloader named Boot CAN1 (see also section 5.1 *Uploading Firmware via CAN* on page 20).

Connectors CAN2 or CAN1 (see assignment tables below) have an additional digital input named Din0 which can be utilized by the microcontroller.



Pin distribution D-Sub connector

PCAN-Router IPEH-002210:

Pin	Function connector CAN1	Function connector CAN2
1	+5 V for external devices (optional)[1]	+5 V for external devices (optional)[1]
2	CAN1_L	CAN2_L
3	GND	GND
4	Reserved (LIN)	Not used
5	SHIELD	SHIELD
6	Boot CAN1 (High-active)	Not used
7	CAN1_H	CAN2_H
8	Not used	Din0 (Low-active)
9	Supply $+U_{b1}$[2]	Supply $+U_{b2}$[2]

PCAN-Router opto-decoupled IPEH-002211:

Pin	Function connector CAN1	Function connector CAN2
1	+5 V for external devices (optional)[1]	+5 V for external devices (optional, via DC/DC converter)[1]
2	CAN1_L	CAN2_L
3	GND1	GND2
4	Reserved (LIN)	Not used
5	SHIELD	SHIELD
6	Boot CAN1 (High-active)	Not used
7	CAN1_H	CAN2_H
8	Din0 (Low-active)	Not used
9	Supply $+U_{b1}$[3]	Not used

[1] See following subsection 2.1.1

[2] 8 - 26 V DC, up to 30 V from ser. no. 01000

[3] 8 - 26 V DC, up to 30 V from ser. no. 00020

2.1.1 Supplying External Devices via the CAN Connector (D-Sub only)

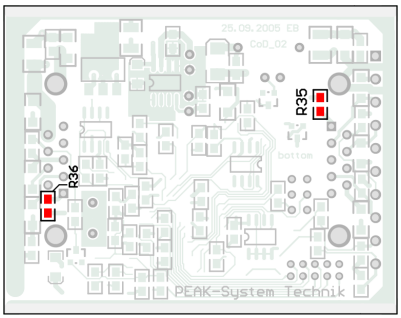
On the circuit board of the PCAN-Router a 5-Volt supply can optionally be routed to each pin 1 of the D-Sub connectors CAN1 and CAN2. Thus devices with low power consumption (e.g. bus converters) can be directly supplied via the CAN connector. The current consumption may not exceed **100 mA** per connector.

➡ Proceed as follows to activate the 5-Volt supply:

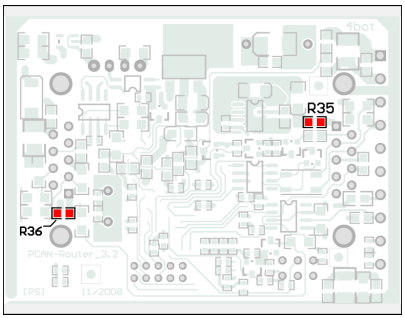
In order to remove the circuit board unscrew the casing of the PCAN-Router on both ends and pull the board from the casing profile.

Set the solder jumper(s) on the circuit board according to the desired settings. During this procedure take especially care not to produce unwanted short circuits on the board.

The following figures show the positions of the solder fields on the bottom side of the PCAN-Router circuit board. The table below contains the possible settings.



IPEH-002210 up to ser. no. 00458



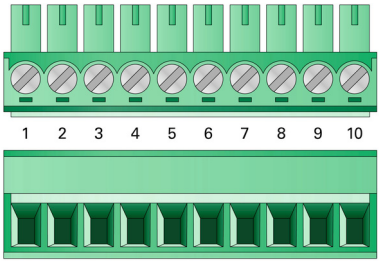
IPEH-002210 from ser. no. 00459 and all IPEH-002211

5-Volt supply →	None	Pin 1
CAN1 (R35)		
CAN2 (R36)		

2.2 Screw Terminal Block

(IPEH-002210-P)

Apart from power supply and CAN channels, the screw terminal block includes connections for a serial interface with RS-232 levels.



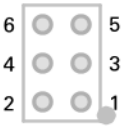
Terminal	Function
1	Supply $+U_b$ [4]
2	GND
3	CAN1_L
4	CAN1_H
5	CAN2_L
6	CAN2_H
7	Boot CAN1 (High-active)
8	Reserved (LIN)
9	RS-232 RxD
10	RS-232 TxD

For further connection details that are not needed for programming of the PCAN-Router because of implementation in a library, see also Appendix C *Port Assignment of the Microcontroller* on page 31.

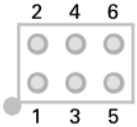
[4] 8 - 26 V DC, up to 30 V from ser. no. 01000

2.3 J4 Connector Panel: Serial Ports

The unpopulated connector panel J4 on the board of the PCAN-Router provides an access option to the serial ports of the LPC2129 or LPC2194/01 microcontroller (µC).



IPEH-002210(-P) up to ser. no. 00458



IPEH-002210(-P) from ser. no. 00459 and all IPEH-002211

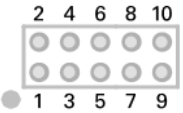
Pin	Signal	Port µC
1	RxD0	P0.1
2	TxD0	P0.0
3	Not used	
4	/Boot_ser	P0.14
5	GND	
6	+5.0 V	

The RxD0 and TxD0 signals are forwarded to a level converter for the RS-232 standard. The PCAN-Router model with screw terminal block provides access to the adjusted signals at terminals 9 (RS-232 RxD) and 10 (RS-232 TxD).

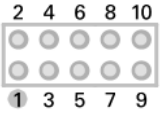
Attention! The RxD0 (pin 1) and TxD0 (pin 2) signals in connector panel J4 are designed for TTL levels only. Using RS-232 levels at these connections can cause damage to the electronics of the PCAN-Router.

2.4 J5 Connector Panel: JTAG Ports

The unpopulated connector panel J5 on the circuit board of the PCAN-Router provides an access option to the JTAG ports of the LPC2129 or LPC2194/01 microcontroller (µC) for hardware debugging.



IPEH-002210(-P) up to ser. no. 00458

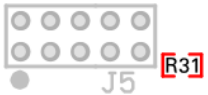


IPEH-002210(-P) from ser. no. 00459 and all IPEH-002211

Pin	Signal	Port µC	Internal wiring
1, 2	GND		
3	/Reset	/Reset	Pull-up
4	3.3 V		
5	TCK	P1.29	Pull-down (R30)
6	TMS	P1.30	Pull-up
7	TDO	P1.27	Pull-up
8	TDI	P1.28	Pull-up
9	RTCK	P1.26	Pull-down (R31)
10	TRST	P1.31	Pull-up

If constant internal pull-down wiring of the TCK or RTCK signals is not suitable for your purposes, you can remove the respective pull-down resistor on the circuit board of the PCAN-Router by soldering it out. Both resistors (each 10 kΩ) are located next to the J5 connector panel J5 (see figures).

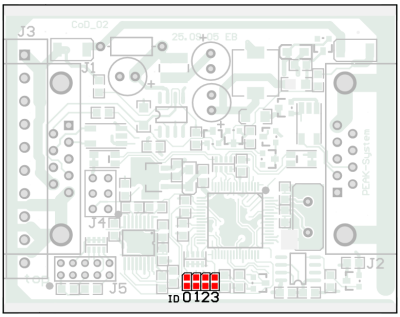
IPEH-002210(-P)
up to ser. no. 00458



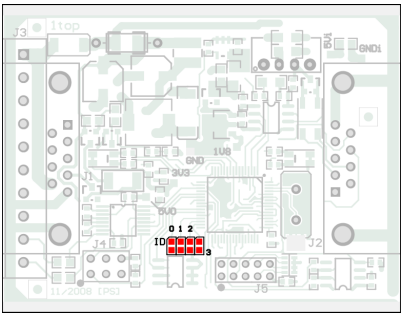
IPEH-002210(-P) from ser. no. 00459 and all IPEH-002211
Top side of the PCB | Bottom side of the PCB

2.5 Coding Solder Jumpers

The four positions for coding solder jumpers (ID 0 - 3) are each assigned to one port of the microcontroller LPC 2129 or LPC2194/01 (µC).



IPEH-002210(-P) up to ser. no. 00458



IPEH-002210(-P) from ser. no. 00459 and all IPEH-002211

Position	0	1	2	3
Port µC	P0.4	P0.5	P0.6	P0.7

Position is …	Status at the port
bridged	Low
open	High

The status of the ports is relevant in the following cases:

- The loaded firmware is programmed so that it reads the status at the corresponding ports of the microcontroller. For example, the activation of certain functions of the firmware or the coding of an ID is conceivable here.

- For a firmware upload via CAN the PCAN-Router is identified by a 4-bit ID which is determined by solder jumpers. A bit is set (1) when the corresponding solder jumper position is open (default setting: ID 15, all positions open).

Position	0	1	2	3
Binary digit	0001	0010	0100	1000
Decimal equivalent	1	2	4	8

See also section 5.1 *Uploading Firmware via CAN* on page 20.

3 Operation

The PCAN-Router is activated by applying the supply voltage to the respective input pins (see chapter 2 *Connectors and Coding Solder Jumpers* on page 7). The firmware in the flash memory is subsequently run.

The PCAN-Router is supplied with an example firmware which forwards CAN messages 1:1 between the two channels at 500 kbit/s. An incoming CAN message causes a change between green and orange of the LED status indication for the respective CAN channel.

The source code for the example firmware 1_ROUTING and further examples is included on the supplied DVD in the following directory branch:

```
/Develop/Microcontroller hardware/PCAN-Router/Example/
```

4 Software

This chapter covers the installation of the Yagarto GNU ARM toolchain and gives notes about the software library and the firmware examples.

Software, source code, and additional information are included on the supplied DVD in the following directory branch:

`/Develop/Microcontroller hardware/PCAN-Router/`

4.1 Installing the GNU ARM Toolchain

To compile the code examples and the custom firmware code under Windows, install Yagarto on your computer. Yagarto is a collection of tools to develop applications for ARM processors and microcontrollers on Windows platforms. The collection includes the GNU GCC compiler for C and C++, Make, and further tools. Further information about Yagarto: www.yagarto.de

System requirement: Windows 8/7/Vista/XP (32/64-bit)

Do the following to install Yagarto:

1. From the directory branch on the provided DVD mentioned above, change to the `Compiler` subdirectory.

   The directory contains the two installation programs `yagarto-*.exe` and `yagarto-tools-*.exe`.

2. Execute the first installation program and follow its instructions.

   If you don't want to use the default destination folder, make sure that your customized path doesn't contain any spaces. Otherwise compile operations will not work later.

3. Afterwards, execute the second installation program and follow its instructions.

In the system environment, the installation programs create search paths for the executable files. These new search paths are effective only for programs and command prompts that are started afterwards.

4.2 Library

The development of applications for the PCAN-Router is supported by the library `libPCAN-RouterGNU*ys.a` (`*` stands for version number), a binary file. You can access all resources of the PCAN-Router by means of this library. The library is documented in the header files (`*.h`). The files are located in each example directory.

From version 2 of the library, all models of the PCAN-Router are supported. Software code that is based on a previous version of the library can be used with version 2 without any changes.

4.3 Firmware Examples

On the DVD, the `Example` subdirectory contains source code for several firmware examples that you can use and test directly and that you can reuse for custom firmware.

On delivery the PCAN-Router is supplied with the example firmware `1_ROUTING`. It forwards CAN messages 1:1 between the two CAN channels at 500 kbit/s. An incoming CAN message causes a change between green and orange of the LED status indication for the respective CAN channel.

4.3.1 Compiling a Firmware Example

Do the following to compile a firmware example under Windows:

1. From the provided DVD, copy the subdirectory of the desired example from the `Example` directory to the local hard disk.
2. Open a **command prompt** by using the Windows Start menu. Alternatively you can press the key combination ⊞ + R and enter `cmd.exe` as program to be executed.
3. At the command prompt change to the previously copied directory.
4. Execute the following command in order to clean-up the target directories (e.g. `.out`) from files that have been generated earlier:

   ```
   make clean
   ```

5. Execute the following command to compile the firmware example:

   ```
   make all
   ```

   If the compiler has finished without errors (“Errors: none”), you can find the firmware file with the extension `.bin` in the subdirectory `.out`. This file is then used for firmware upload to the PCAN-Router.

5 Firmware Upload

The microcontroller in the PCAN-Router can be equipped with new firmware in two different ways:

- Via CAN. The scope of supply includes the Windows program PCAN-Flash to transfer the firmware from the computer to the PCAN-Router. This is the recommended method for a firmware upload.
- Via the RS-232 interface or the serial connections of the microcontroller. For the latter access to the board of the PCAN-Router is needed.

5.1 Uploading Firmware via CAN

5.1.1 System Requirements

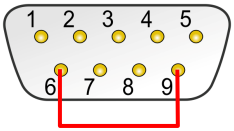
The following prerequisites must be given, so that the PCAN-Router can be updated with new firmware:

- CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
- CAN cabling between the CAN interface and the PCAN-Router with proper termination (120 Ω on each end of the CAN bus)
- Operating system Windows 8/7/Vista/XP (32/64-bit)
- If you want to update several PCAN-Router connected to the same CAN bus, you must assign a unique ID to each router. See section 2.5 *Coding Solder Jumpers* Seite 14.

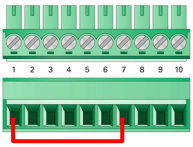
5.1.2 Preparing Hardware and Software

- Perform the following steps for preparation of the hardware:

1. Switch the PCAN-Router off by disconnecting it from the power supply.
2. Establish a connection between “Boot CAN1” and “+U_{b1}” or “+U_b” at the connectors of the PCAN-Router.



Connection at D-Sub connector CAN1 between the pins 6 and 9



Connection at the screw terminal block between terminals 1 and 7

This measure later applies the “Boot CAN1” connection with a high level.

3. Connect CAN bus 1 of the PCAN-Router with a CAN interface connected to the computer. Pay attention to the proper termination of the CAN cabling (2 x 120 Ω).

   Uploading firmware via CAN bus 2 is not possible.

⚠ **Attention!** Risk of short circuit! A CAN cable with D-Sub connectors must not have a connection on pin 6, as it can be seen on 1:1 cables, for example. At other CAN nodes (e.g. a CAN interface of the PCAN series) this line may be applied to the mass. Damage or destruction of the electronics is a possible consequence.

- Perform the following steps for preparation of the software:

1. On the supplied DVD, change to the following directory: `/Develop/Microcontroller hardware/PCAN-Router/`
2. Copy the subdirectory `PcanFlash` to the local hard disk.

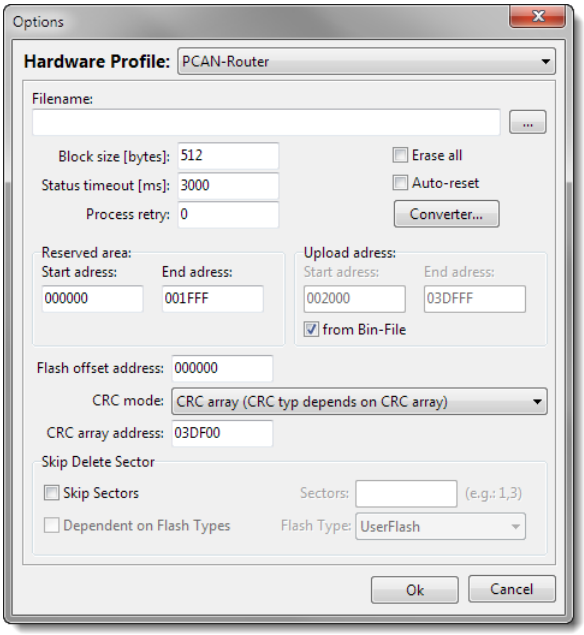
The contained Windows software that copies the Firmware via CAN (`PcanFlash.exe`) can only be started from a data carrier that is writable.

5.1.3 Uploading the Firmware

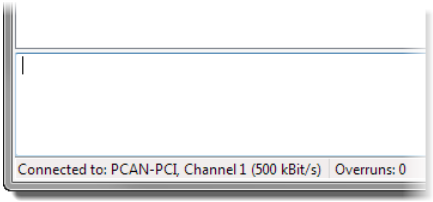
The process of uploading new firmware to the PCAN-Router is as follows:

1. Ensure that a connection is established between the "Boot CAN1" and "+U_{b1}" or "+U_b" connections of the PCAN-Router (details: see above).
2. Switch the PCAN-Router on by applying voltage supply.

   Due to the High level at the "Boot CAN" connection, the PCAN-Router starts the CAN bootloader. This can be identified by two orange LEDs. Starting with version 2 of the CAN bootloader (standard on IPEH-002210(-P) from ser. no. 00300 and all IPEH-002211) the LED "CAN1" blinks.
3. Run the program `PcanFlash.exe` under Windows from the local hard drive.
4. Click on the (Options) button in order to call up the dialog box.
5. From the **Hardware Profile** dropdown list, select the **PCAN-Router** entry.

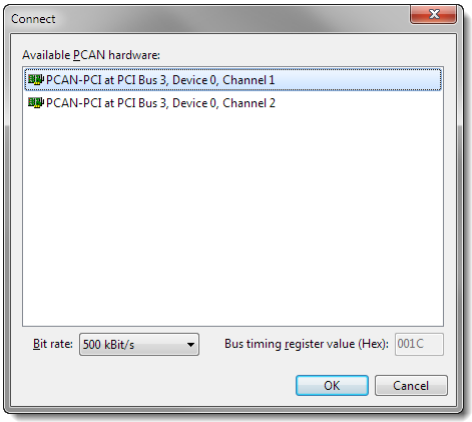


6. Click on the … button next to the **File name** field in order to select the desired firmware file (`*.bin`) to be uploaded.
7. Click on the **OK** button.
8. Make sure that the PCAN-Flash program is connected with 500 kbit/s to the available CAN interface at the computer.



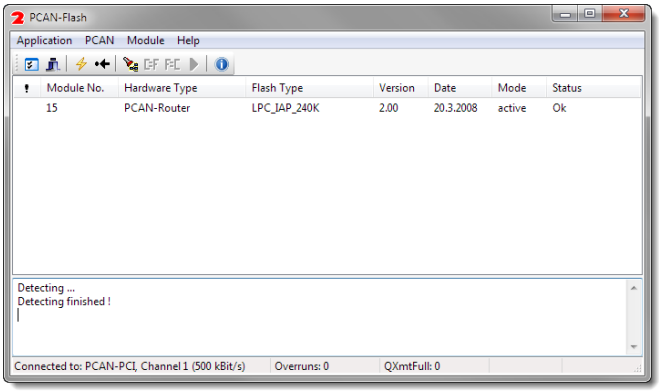
PCAN-Flash: Display of a connection in the status bar on the bottom.

If not, click the (Connect) button in order to change the selection in the according dialog box.



9. Click the (Detect) button in order to detect the PCAN-Router connected to the CAN bus.

   An entry for the PCAN-Router appears in the main window.



10. Select the entry for the PCAN-Router.

11. Click the (Program) button in order to start uploading the new firmware to the PCAN-Router.

Observe the status indication at the bottom of the window. The process was successful if the last message to appear is "Flashing of module(s) finished!".

12. Disconnect the power supply from the PCAN-Router.
13. Disconnect "Boot CAN1" from "+U_{b1}" or "+U_b".

You can now use the PCAN-Router with the new firmware.

5.2 Uploading Firmware via the Serial Connections

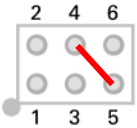
This section shows how to activate the microcontroller's boot-loader. The actual upload process depends on the upload software used which is supplied by a third party and is not described here.

Important note: When uploading a firmware via the RS-232 interface, the CAN bootloader may be overwritten. Afterwards a firmware upload via CAN is not possible anymore.

Do the following to activate the microcontroller's bootloader:

1. Switch the PCAN-Router off by disconnecting it from the power supply.
2. Open the casing of the PCAN-Router by removing the screws in order to gain access to the board.
3. Establish a connection on the J4 connector panel between pin 4 (\Boot_ser) and pin 5 (GND).

IPEH-2210(-P) up to ser. no. 00458



IPEH-2210(-P) from ser. no. 00459 and all IPEH-2211

4. Establish a serial connection to the computer or program adapter. This is carried out either via the RS-232 interface (IPEH-002210-P only) or via the serial ports of the microcontroller (TTL levels). See also chapter 2 *Connectors and Coding Solder Jumpers* on page 7.

5. Switch the PCAN-Router on by applying voltage supply.

   Due to the Low level on port P0.14 of the microcontroller, the PCAN-Router starts the bootloader for serial copying. Neither LED is illuminated.

6 Technical Specifications

Functionality	
Microcontroller	NXP LPC2194/01 with a clock speed of 60 MHz (IPEH-2210(-P) up to ser. no. 00299: NXP LPC2129) Firmware upload via CAN with special bootloader or serial
Add-on memory	256 kbit, EEPROM Atmel AT24C256B (via I^2C) (IPEH-2210(-P) up to ser. no. 00299: 2 kbit, Microchip 24LC02B)
CAN	2 x High-speed CAN ISO 11898-2 Transceiver NXP TJA1040T Bit rates 40 kbit/s - 1 Mbit/s (lower bit rates on request) No termination
LIN	1 LIN channel (on request)
RS-232	RxD and TxD serial connections with RS-232 levels (IPEH-002210-P only)
Digital input (Din0)	Low-active, max. level $+U_b$ (IPEH-002210/11 only)
Status indication	2 duo LEDs
Connectors	IPEH-002210: 2 x D-Sub connector, 9-pin, assignment according to specification CiA® 102 IPEH-002210-P: 1 x screw terminal block, 10-pin, pitch 3.81 mm (Phoenix Contact MC 1,5/10-ST-3,81 - 1803659) IPEH-002211: like IPEH-002210, galvanic isolation for connector CAN2 up to 500 V

Power supply	
Voltage supply ($+U_b$)	8 - 26 V DC up to 30 V with IPEH-002210(-P) from ser. no. 01000 and IPEH-002211 from ser. no. 00020
Current consumption	max. 70 mA at 12 V

Continued on the next page

Measures	
Size	Casing: 70 x 55 x 24 mm (L x W x H) Circuit board: 65 x 51 mm (L x W) See also dimension drawings in Appendix A on page 29
Weight	IPEH-002210: 100 g IPEH-002210-P: 100 g (incl. screw terminal block) IPEH-002211: 100 g

Environment	
Operating temperature	-40 - +85 °C (-40 - +185 °F)
Temperature for storage and transport	-40 - +100 °C (-40 - +212 °F)
Relative humidity	15 - 90 %, not condensing
EMC	EN 61326-1:2013-07 EC directive 2004/108/EG
Ingress protection (IEC 60529)	IP20

Appendix A CE Certificate

PCAN-Router IPEH-002210(-P) and IPEH-002211 – EC Declaration of Conformity
PEAK-System Technik GmbH

Notes on the CE Symbol CE

The following applies to the "PCAN-Router" product with the item number(s) IPEH-002210(-P) and IPEH-002211.

EC Directive This product fulfills the requirements of EU EMC Directive 2004/108/EC (Electromagnetic Compatibility) and is designed for the following fields of application as for the CE marking:

Electromagnetic Immunity/Emission
DIN EN 61326-1, publication date 2013-07
Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements (IEC 61326-1:2012);
German version EN 61326-1:2013

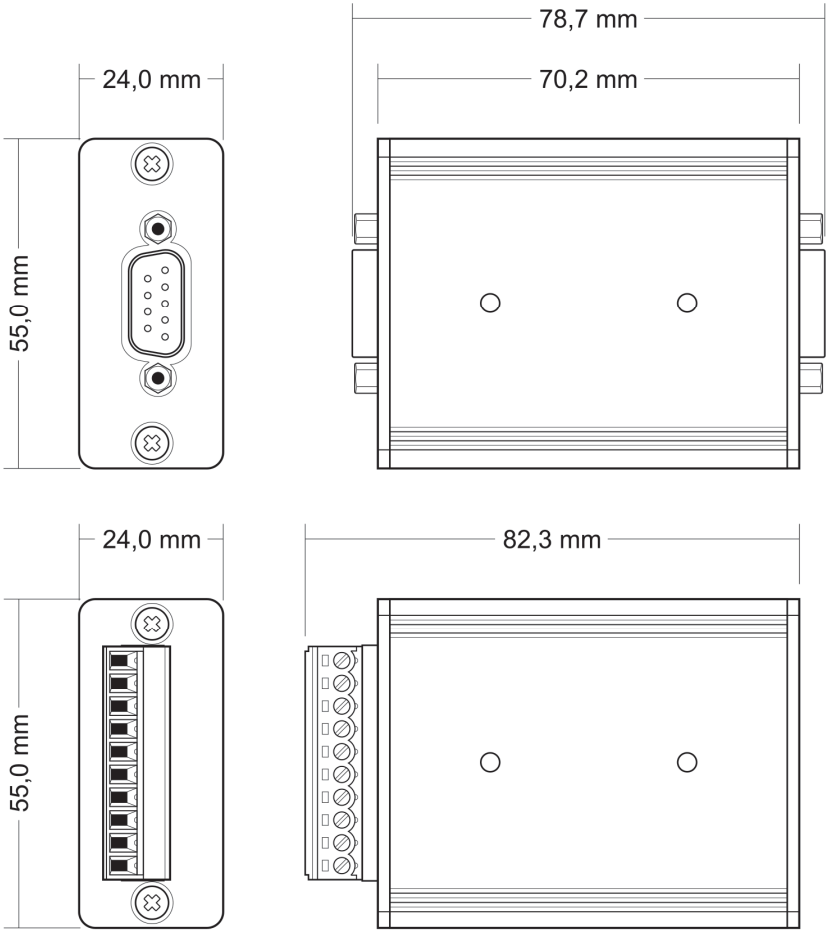
Declarations of Conformity In accordance with the above mentioned EU directives, the EC declarations of conformity and the associated documentation are held at the disposal of the competent authorities at the address below:

PEAK-System Technik GmbH
Mr. Wilhelm
Otto-Roehm-Strasse 69
64293 Darmstadt
Germany

Phone: +49 (0)6151 8173-20
Fax: +49 (0)6151 8173-29
E-mail: info@peak-system.com

Signed this 22nd day of October 2013

Appendix B Dimension Drawings



The figures do not show the original size.

Appendix C Port Assignment of the Microcontroller

The following table lists the used inputs and outputs (ports) of the LPC2129 and LPC2194/01 microcontroller (µC) and their function in the PCAN-Router. It is meant as supplemental information. The converter's functionality is implemented by the supplied library.

Get additional information about the LPC2129 and LPC2194/01 microcontrollers on the homepage of NXP (www.nxp.com).

Port	I/O	µC function	Signal	Active (µC)	Function/connection[5]
P0.0	O	TxD UART0	TxD0		Serial communication, Transmit, J4:2 or STB:10 (RS-232 levels)
P0.1	I	RxD UART0	RxD0		Serial communication, Receive, J4:1 or STB:9 (RS-232 levels)
P0.2	I, O	SCL	SCL		I^2C bus to the EEPROM Microchip 24LC02B or Atmel AT24C256B[6]
P0.3	I, O	SDA	SDA		
P0.4	I	Port pin	ID0	High	Coding solder jumpers on board (ID 0 - 3), bridged = Low
P0.5	I	Port pin	ID1	High	
P0.6	I	Port pin	ID2	High	
P0.7	I	Port pin	ID3	High	
P0.8	O	TxD UART1	LIN_TxD		LIN Transmit[7]
P0.9	I	RxD UART1	LIN_RxD		LIN Receive[7]

[5] CAN1/2:n Pin n of the respective D-Sub connector
STB:n Terminal n on the screw terminal block
J4/5:n Pin n of the respective connector panel on the board

[6] PCAN-Router IPEH-002210(-P) from serial number 00300 and all IPEH-002211

[7] This function is only available if the PCAN-Router is equipped with the optional LIN transceiver (on request).

Port	I/O	µC function	Signal	Active (µC)	Function/connection[5]
P0.10	O	Port pin	LIN_en	High	Enable LIN transceiver[7]
P0.11	I	Hardware capture with timer	LIN_RxD		e.g. bit rate measurement on the LIN bus[7], connected to P0.9/18/20
P0.12	O	Port pin			Reserved
P0.13	I, O	Port pin			
P0.14	I	Port pin	/Boot_ser	Low	Activate flashing via serial interface, J4:4
P0.15	I	Port pin	/Boot_CAN	Low	Activate flashing via CAN1 with 500 kbit/s, CAN1:9 and STB:7 (due to wiring High-active)
P0.17	O	Port pin	V24_en	High	Deactivate the RS-232 converter by Low level (activated by default); possibility for energy saving
P0.18	I	Hardware capture with timer	LIN_RxD		e.g. bit rate measurement on the LIN bus[7], connected to P0.9/11/20
P0.19	I	Port pin	Switch	High	Digital input Din0, CAN2:8 (due to wiring Low-active)
P0.20		Hardware capture with timer	LIN_RxD		e.g. bit rate measurement on the LIN bus[7], connected to P0.9/11/18
P0.21	O	Port pin	CAN_en_2	Low	Activate the respective CAN transceiver[8]
P0.22	O	Port pin	CAN_en_1	Low	
P0.23	I	RD2	CAN2_RxD		CAN2 Receive
P0.24	O	TD2	CAN2_TxD		CAN2 Transmit
P0.25	I	RD1	CAN1_RxD		CAN1 Receive
TD1	O	TD1	CAN1_TxD		CAN1 Transmit

[8] After resetting the microcontroller, the CAN transceivers are deactivated and must be reactivated to use them.

Port	I/O	µC function	Signal	Active (µC)	Function/connection[5]
P0.27	I	Analog input	V-Power2		Measure voltage $+U_{b2}$, maximum value (0x03FF) corresponds to approx. 16.5 V
P0.28	I	Analog input	V-Power1		Measure voltage $+U_{b1}$ or $+U_{b}$, maximum value (0x03FF) corresponds to 33.1 V
P0.29	I	Analog input			Lies on GND
P0.30	I	Analog input			Lies on 1.8 V (microcontroller supply)
P1.16	O[9]	Port pin		Low	LED CAN1 red
P1.17	O[9]	Port pin		Low	LED CAN1 green
P1.18	O[9]	Port pin		Low	LED CAN2 red
P1.19	O[9]	Port pin		Low	LED CAN2 green
P1.25	O	LIN Term		High	Switching master termination for LIN
P1.26		JTAG interface	RTCK		Debugging, J5:9
P1.27		JTAG interface	TDO		Debugging, J5:7
P1.28		JTAG interface	TDI		Debugging, J5:8
P1.29		JTAG interface	TCK		Debugging, J5:5
P1.30		JTAG interface	TMS		Debugging, J5:6
P1.31		JTAG interface	TRST		Debugging, J5:10

[9] It may occur that an LED glows slightly when the respective output is inactive. If you would like to prevent this, your firmware must change the port type to input (I). Before switching on the LED again, the respective port type must be set to output (O).